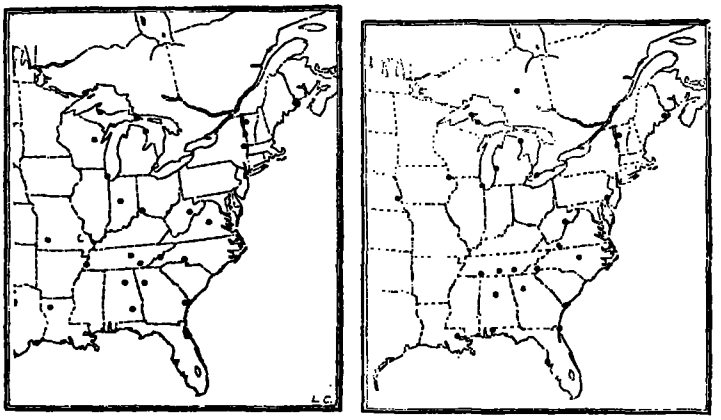
EASTERLY MOVEMENT OF CIRRUS CLOUDS.

By LEON J. GUTHRIE, Meteorologist.

[Dated: Weather Bureau, Fort Smith, Ark., Sept. 27,1919.]

During the period 1909 to 1919, inclusive, cirrus or cirro-stratus clouds were observed moving from an easterly direction at 107 regular or special observations. They moved from the northeast 49 times; from the east, 25 times; from the southeast, 33 times.

The dates of movement from the northeast were: 1909; April 4, August 3, 5, and 23. 1910; June 18,

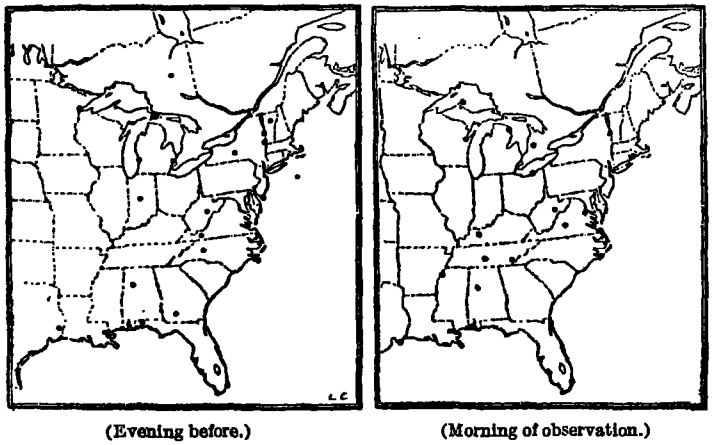


(Evening before.) (Morning of observation.)

FIG. 1.—Locations of high pressure centers at times of cirrus movements from the NE. at Fort Smith, Ark.

July 18, 26, 27, and 28. 1911; June 21, July 4, and August 15. 1912; June 28, July 22 and 26. 1913; April 6 May 14, July 8, 23, and August 20. 1914; July 11. 1915; April 15. 1916; July 15, 31, August 4, 19, 20, and 22. 1917; June 9, 28, July 3, 15, 17. 1918; July 4, 5, August 3, 13, September 28. 1919; July 5, 9, 10, 15, September 1, 2, 7, 11.

Movement from due east occurred: 1909; April 14, August 13. 1910; July 29. 1911; June 22, July 2.

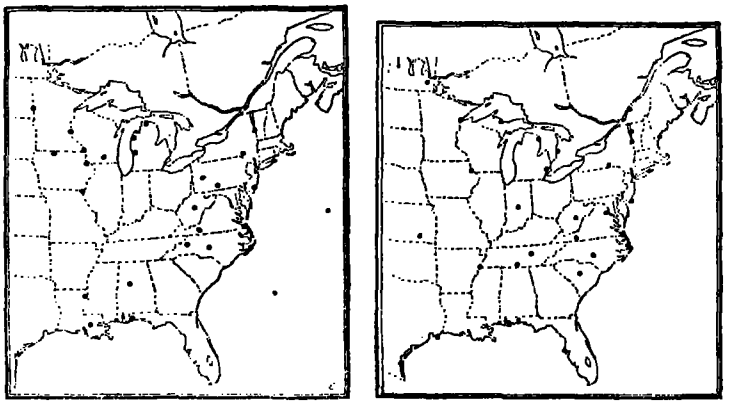


(Evening before.) (Morning of observation.)

FIG. 2.—Locations of high pressure centers at times of cirrus movements from the E. at Fort Smith, Ark.

1912; July 3, 12, August 28. 1913; June 5, September 7. 1914; August 2. 1915; July 12. 1916; July 28, August 16, 18, 21. 1918; August 9, September 27. 1919; June 22, July 7, 8, 31, September 3.

Movement from the southeast: 1909; August 24, September 4. 1910; June 23, July 13, 15. 1911; July 3, 5, 7. 1912; June 14, July 5, 12, 25, 26. 1914; August 22, September 29. 1915; July 13, 18, 29, September 17. 1916; August 17, 18. 1917; July 23. 1918; March 30. 1919; May 30, June 1, 17, 22, 23, July 2, 30, August 1, September 6.



(Evening before.) (Morning of observation.)

FIG. 3.—Locations of high pressure centers at times of cirrus movements from the SE. at Fort Smith, Ark.

It appears that a well-defined High east of the Mississippi River is necessary to produce the westward movement, as its occurrence has been noted only four times when other conditions obtained. The few exceptions may possibly have been caused by a local condition of unusually active convection. Assuming that the exact location of the Low is of minor consideration, though a trough-like depression extending northeastward from western Texas seems to predominate, attention was chiefly centered upon the location, extent, and development of the Highs.

Charts upon which dots represent the station of highest pressure east of the Mississippi River, on evenings of days immediately preceding, and mornings of days corresponding to the observations, were prepared from the evening and morning Washington weather maps. Separate charts for movements from the northeast, east, and southeast are shown figures 1–3.

Movement from the northeast occurred with HIGHS centered in every State east of the Mississippi River, but the chart shows groupings over the upper Lake Region and in northern Florida and eastern Georgia. Smaller groupings appear in the Ohio Valley and New England.

The chart for movement from due east shows widely scattered centers, with no significant groupings.

For southeasterly movement the groupings shift southward, as might have been expected, congesting along the South Atlantic coast and the eastern Gulf coast. For this direction few centers appear north of the Ohio Valley.

Although, in a general way, the location of the High seems to determine the westward drift, a vast majority of maps that show conditions apparently ideal are not attended by other than the normal westerly movement. But it seems to be an almost invariable rule that when the eastern High develops materially, especially when the pressure increases westward or southwestward through a part, or all, of the lower Mississippi Valley and the middle Gulf States, the phenomenon attends. Numerous maps show this tendency on dates of observed easterly drift. The following dates will suffice for a study of this feature: 1909; April 14–15, August 13–14, August 24–25. 1910; July 12–13. 1911; July 5–7. 1912; July 2–3, July 12–13. 1915: July 18–19, September 16–17.

1916; August 16–18. 1919; June 16–18, July 7–10, September 3–4.

A close study of local conditions on June 22–24, 1919, suggested that marked local convection might temporarily divert the cirrus from a normal path. Active convection during the forenoon of June 22, as shown by highly developed cumuli, was followed, during the afternoon, by a succession of thunderstorms that apparently formed northeast of the station and developed westward and southwestward. True cirrus moved from the east at 7 a. m., 11 a. m., and 12 noon, and cirro-stratus from the southeast at 3.45 p. m., 4.45 p. m., and 7 p. m. Thunderstorm conditions continued through the 23d. On that day the cirro stratus moved from the southeast at 7 a. m., 3.15 p. m., and 6 p. m. Active convection ceased by the morning of the 24th and the clouds returned to their normal drift.

Similar conditions appear to have existed on September 4, 1909, June 23, 1910, June 22, 1911, July 17, 1912, July 15, 1916, and July 28, 1916, but the entire series of observations does not furnish sufficient data for a productive investigation of this feature.

THE WEST INDIA HURRICANE OF SEPTEMBER, 1919, IN THE LIGHT OF SOUNDING OBSERVATIONS.

By R. HANSON WEIGHTMAN, Meteorologist.

[Dated: Weather Bureau, Washington, Dec. 3, 1919.]

The hurricane of September, 1919, is the first well-developed storm of tropical origin in connection with which sounding observations of wind directions and speeds in the free air are available for study purposes. In 1906 and 1907 while Rotch and de Bort were conducting sounding balloon and kite work [1] in the southeastern portion of the North Atlantic Ocean several disturbances of minor importance occurred in the West Indies but, unfortunately, many hundred miles away from the point where observations were being made. Again in the early part of August, 1918, a disturbance of intense character but of very limited extent developed in the Gulf of Mexico and passed inland west of New Orleans during the 6th. The nearest point to the storm at which sounding observations are available is Fort Sill, Okla., about 500 miles distant. On the mornings of the 5th and 6th at this station the winds up to the greatest elevation reached, the 2,000 meter level, were from the SW., 10 to 18 m. p. s., and at noon of the 6th they had backed to SSW. and decreased somewhat in velocity, seemingly unaffected in any way by the disturbance.

In the September, 1919, hurricane upper-air observations are available from three stations in Texas, two in Oklahoma, one in Georgia, and from nine or ten other stations outside of the Gulf States. The most complete series of observations from a point relatively near the hurricane center is from the Leesburg, Ga., station, the nearest point reached by the storm center, however, being about 500 miles. At the time the disturbance was approaching southern Texas, the sky over that region unfortunately became overcast for the most part, thereby preventing the making of observations at greater altitudes than 3.5 km. and in most cases under 2.

Perhaps the most interesting feature brought out by these observations is the rather sudden change in wind direction as shown by sounding balloons at Leesburg. For several days previous to September 5, the winds above 3 km. were from a westerly quarter while near the surface they were between north and east. On the 1st westerly winds were first encountered at the 2 km. level, on the 2d at the 3-km. level, on the 3d at 3-km., on the morning of the 4th they had descended to 2 km. and by evening had risen to 3.5 km. On the morning of the 5th they were first observed at the 4-km. level and by the afternoon of that date were not in evidence up to 11 km., the greatest altitude reached. So far as observations are available, no trace of westerly winds is found until the morning of the 12th, when they were encountered at an elevation of 6 km., and by the afternoon of that date they had descended to 4.5 km. This shift of the upper winds to W. and N. seems to have been of a temporary character, for on the 15th they were generally between ENE. and ESE. up to 11 km., and it was not until the 16th that they changed to steady westerly.

A current from the east was then fully established at Leesburg at all altitudes up to probably 10 km., at least, from the evening of the 5th to the morning of the 12th, a rather unusual occurrence, if we may judge from a casual inspection of the observations made during the two or three preceding months. In the lower strata, at least, this distribution of winds is consistent with the surface barometric distribution, for during the time of the prevalence of the easterly winds pressure was relatively high over the southern Appalachian region and the interior of the east Gulf States and relatively low to the southward. The persistence of the easterly winds in the upper layers, however, appears to be quite unusual. This easterly current is also in evidence up to the 5 km. level at the south Texas stations, i. e., Groesbeck, Ellington Field near Houston, and Kelly Field near San Antonio, from the 1st of the month until the time the hurricane crossed the Gulf coast about 50 miles south of Corpus Christi on the 14th. The highest levels shown by the observations do not exceed 5 km. except in two cases; one on the morning of the 5th at Kelly Field, showed winds between N. and NW. between 5 and 10 kilometers. This easterly current seems to have a rather well-marked limit, for the stations at Broken Arrow and Fort Sill, both in Oklahoma and less than 500 miles to the northward, showed a number of observations between the 5th and 10th of the month, in which the winds were from a westerly quadrant. Likewise, with the easterly winds observed at Leesburg, the northern boundary must have been quite well defined for the sounding observations at Washington about 750 miles distant show practically all winds from a westerly quarter. The southern limit of the easterly current is rather difficult to determine, but an examination of the cloud observations at Swan Island, Belize, and Bluefields shows that easterly winds prevailed in the cumulus level (about 2,000 meters) up to the 8th. During the 4th a minor disturbance passed over Santo Domingo, advanced northwestward to the west of Turks Island by the morning of the 5th, and from that point recurved to the northeastward. On the evening of the 6th after the passage of this disturbance the winds over Jamaica in the cumulus level were southerly, over Haiti southeasterly,

[1] Etude de l'atmosphère marine par sondages aériens; Atlantique moyen et récion intertropicale. Par Mm. L. Teisserenc de Bort et Lawrence Rotch. Travaux Scientifiques de l'observatoire de Météorologie Dynamique de Trappes. Tome IV.